



## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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<b>(60) Parent Application or Grant</b> (63) Related by Continuation US Filed on 580,239 (CIP) 10 September 1990 (10.09.90)			
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**(54) Title:** MOMETASONE FUROATE MONOHYDRATE, PROCESS FOR MAKING SAME AND PHARMACEUTICAL COMPOSITIONS

**(57) Abstract**

The invention relates to the novel compound mometasone furoate monohydrate, process for its preparation and pharmaceutical compositions containing said compound.

#### + DESIGNATIONS OF "SU"

Any designation of "SU" has effect in the Russian Federation. It is not yet known whether any such designation has effect in other States of the former Soviet Union.

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**MOMETASONE FUROATE MONOHYDRATE, PROCESS  
FOR MAKING SAME AND PHARMACEUTICAL  
COMPOSITIONS**

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**BACKGROUND OF THE INVENTION**

The present invention relates to a novel composition of matter, 9 $\alpha$ ,21-dichloro-16 $\alpha$ -methyl-1,4-pregnadiene-11 $\beta$ ,17 $\alpha$ -diol-3,20-dione-17-(2'-furoate) monohydrate, also designated mometasone furoate monohydrate, process for its preparation, and pharmaceutical preparation thereof.

Mometasone furoate is known to be useful in the treatment of inflammatory conditions. The compound is prepared by procedures disclosed in U.S. Patent No. 4,472,393, which patent is hereby incorporated by reference.

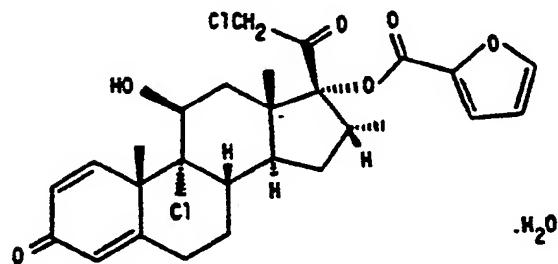
When aqueous pharmaceutical compositions, e.g. suspensions, containing anhydrous mometasone furoate were subjected to stability testing by rotating for four weeks at room temperature and 35°C, formation of a crystalline material which is different from the anhydrous mometasone furoate crystal was observed in suspension. Experiments were designed to determine the nature of the crystalline material. It was postulated that formulation of mometasone furoate compositions with the stable crystalline form would reduce the probability of crystal growth during long term storage of the suspension leading to a more stable product.

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### SUMMARY OF THE INVENTION

The present invention provides mometasone furoate monohydrate of formula I

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a process for preparing said compound by crystallization from a saturated aqueous water miscible organic solution. The present invention also provides aqueous stable pharmaceutical compositions of mometasone furoate monohydrate.

### DESCRIPTION OF THE FIGURES

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Figure 1: Infrared spectrum of crystalline mometasone furoate monohydrate

Figure 2: X-ray diffraction pattern of crystalline mometasone furoate monohydrate

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### DETAILED DESCRIPTION OF THE INVENTION

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The composition of matter of the present invention, mometasone furoate monohydrate has the following characteristics.

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Molecular formula	C <sub>27</sub> H <sub>30</sub> Cl <sub>2</sub> O <sub>6</sub> H <sub>2</sub> O
Formula weight	539.46
Elemental Analysis (theory)	C=60.11%, H=5.98%; Cl=13.16%
(found)	C=59.99%; H=5.56%; Cl=13.17%
5 Water Analysis (% H <sub>2</sub> O) (theory)	3.34%
	(found) 3.31, 3.47

The crystalline mometasone furoate monohydrate  
exhibits an x-ray crystallographic powder diffraction pattern  
10 having essentially the values as shown in Table I.

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TABLE I

---

5	Angle of $2\theta$ (degrees)	Spacing d (Å)	Relative Intensity I/I
10	7.795	11.3324	100
	11.595	7.6256	6
	12.035	7.3478	3
	12.925	6.8437	11
	14.070	6.2893	22
	14.580	6.0704	5
15	14.985	5.9072	12
	15.225	5.8146	33
	15.635	5.6631	96
	16.710	5.3011	15
	17.515	5.0592	14
20	18.735	4.7324	12
	20.175	4.3978	13
	20.355	4.3593	6
	20.520	4.3246	4
	21.600	4.1108	5
25	21.985	4.0396	22
	22.420	3.9622	8
	22.895	3.8811	7
	23.245	3.8234	14
	23.550	3.7746	13
30	24.245	3.6680	4
	24.795	3.5878	11
	24.900	3.5729	5
	25.800	3.4503	5
	25.985	3.4262	3
35	26.775	3.3268	84
	27.170	3.2794	10
	27.305	3.2635	9

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	Angle of $2\theta$ <u>(degrees)</u>	Spacing d (Å)	Relative Intensity I/I
5			
10	27.710	3.2167	5
	28.385	3.1417	7
	29.165	3.0594	1
	29.425	3.0330	2
	29.725	3.0030	2
	30.095	2.9670	7
15	30.255	2.9516	3
	30.490	2.9294	10
	30.725	2.9075	6
	31.115	2.8720	3
	31.595	2.8294	47
	32.135	2.7831	6
20	32.985	2.7133	7
	33.400	2.6805	2
	33.820	2.6482	2
	34.060	2.6301	8
	34.625	2.5885	4
	34.795	2.5762	2
25	35.315	2.5394	1
	36.780	2.4416	21
	37.295	2.4090	2

Single crystal data of mometasone furoate  
30 monohydrate exhibits the following values as shown in Table II.

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TABLE II

Crystallographic Data<sup>a</sup>

5	Crystal system	triclinic
	Space group	P1(C <sub>1</sub> <sup>1</sup> ) - No. 1
	a(Å)	8.481(1)
	b(Å)	11.816(2)
10	c(Å)	7.323(1)
	α(°)	95.00(1)
	β(°)	110.66(1)
	γ(°)	73.27(1)
	V(Å <sup>3</sup> )	657.5(3)
15	D <sub>calcd.</sub> (g cm <sup>-3</sup> )	1.362

<sup>a</sup> An Enraf-Nonius CAD-4 diffractometer (Cu-K $\alpha$  radiation, incident-beam graphite monochromator) was used 20 for all measurements. Intensity data were corrected for the usual Lorentz and polarization effects; an empirical absorption correction was also applied.

The crystal structure was solved by direct methods (RANTAN). Approximate non-hydrogen atom positions were 25 derived from an E-map. Hydrogen atoms were located in a series of difference Fourier syntheses evaluated following several rounds of full-matrix least-squares adjustment of non-hydrogen atom positional and anisotropic temperature factor parameters. Hydrogen atom positional and isotropic 30 thermal parameters were included as variables in the later least-squares iterations which also involved refinement of an extinction correction. Crystallographic calculations were performed on PDP11/44 and MicroVAX computers by use of the Enraf-Nonius Structure Determination Package (SDP). For all 35 structure-factor calculations, neutral atom scattering factors

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and their anomalous dispersion corrections were taken from International Tables for X-Ray Crystallography, vol. IV, The Knynock Press, Birmingham, England, 1974.

Mometasone furoate monohydrate can be prepared  
5 by forming a saturated homogeneous solution of anhydrous mometasone furoate in a mixture of water and a water miscible organic solvent. The saturated solution is prepared by dissolving the mometasone furoate in a water miscible organic solvent at the temperature of about 85°C. Hot water,  
10 about 85°C, is added dropwise with agitation. After removing the solution from the steam bath, the reaction is stirred for about one hour and then allowed to stand undisturbed overnight while cooling to room temperature. The solution is stirred while adding additional water at room temperature  
15 and the solution becomes cloudy and a white precipitate forms. The reaction is allowed to stir for a time, the precipitate collected by filtration and the product dried to constant weight.

Organic solvents that can be employed in the  
20 process of this invention must be miscible with water and one in which mometasone furoate is soluble. Examples of water miscible organic solvents include alcohols, such as, ethanol, isopropanol, and the like; ketones, such as acetone, and the like; ethers, such as dioxane, and the like; esters such as ethyl acetate, and the like. The preferred solvents are acetone and isopropanol.

In another aspect, the present invention provides pharmaceutical compositions comprising mometasone furoate monohydrate of formula I in an inert pharmaceutically acceptable carrier or diluent.  
30

The pharmaceutical compositions according to the invention can be prepared by combining mometasone furoate monohydrate with any suitable inert pharmaceutical carrier or

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diluent and administered orally, parentally or topically in a variety of formulations.

Of particular interest are aqueous suspension compositions of mometasone furoate monohydrate, e.g. for 5 nasal administration. The aqueous suspensions of the invention may contain from 0.1 to 10.0mg of mometasone furoate monohydrate per gram of suspension.

The aqueous suspension compositions according to the present invention may contain, inter alia, auxiliaries 10 and/or more of the excipients, such as: suspending agents, e.g. microcrystalline cellulose, sodium carboxymethylcellulose, hydroxypropyl-methyl cellulose; humectants, e.g. glycerin and propylene glycol; acids, bases or buffer substances for adjusting the pH, e.g. citric acid, sodium citrate, phosphoric 15 acid, sodium phosphate e.g. citrate and phosphate buffers; surfactants, e.g. Polysorbate 80; and antimicrobial preservatives, e.g. benzalkonium chloride, phenylethyl alcohol and potassium sorbate.

The following examples illustrate the present 20 invention and the best mode of practicing the process of the invention. It will be apparent to those skilled in the art that modifications thereof may be practical without departing from the purpose and intent of this disclosure.

25

#### General Experimental

Infrared absorption spectra were taken as Nujol Mull on a Nicolet FT-Infrared spectrometer Model No. 5DXB. X-ray crystallograph powder diffraction patterns were taken on 30 a Philips X-ray diffractometer Model APD-3720 equipped with a radiation source: copper K $\alpha$ . Decomposition temperatures were measured on a Dupont differential scanning calorimeter, Model No. 990.

Moisture content of the crystalline mometasone furoate monohydrate was determined by titration with Karl Fisher reagent.

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EXAMPLE 1

Place 4.5 liters of ethyl alcohol into a suitable vessel equipped with an appropriate agitator and closure.

- 5 Dissolve 27g of mometasone furoate anhydrous powder into the ethanol with stirring. Filter the saturated solution and slowly add purified water about 1.5 liters, at a flow rate of approximately 50 ml/minute while stirring at moderate speed. When the solvent mixture reaches a ratio of 1:3
- 10 (water:ethanol), the addition of water is stopped and stirring of the reaction mixture is continued for approximately 2 hours to facilitate seeding. Resume addition of water, about 7.5 liters at a rate of approximately 50 ml/minute, until a ratio of 2:1 (water:ethanol) is achieved. Continue stirring to complete
- 15 crystallization. The crystals are collected by filtration and dried in a vacuum desiccator at room temperature to afford 24.83g of mometasone furoate monohydrate having an infrared spectrum and X-ray diffraction graph substantially the same as that in Figures 1 and 2.

20

EXAMPLE 2

Place 24.3 liters of 2-propanol into a suitable container. Dissolve 340 grams of anhydrous mometasone

- 25 furoate in the 2-propanol by heating the mixture (steam bath) to 85°C with stirring. After the furoate has dissolved, add dropwise with stirring over 15 minutes 1950 ml of hot (85°C) water. The hot solution is removed from the steam bath and the solution is stirred for 1 hour. The solution is allowed to cool to room temperature overnight without stirring. The remainder of water, about 24 liters is added with stirring; the solution becomes cloudy and a white precipitate begins to form. The reaction is stirred for one hour, following addition of the water. The white precipitate is collected by filtration,
- 30

- 10 -

washed with 2 liters of water and air dried overnight. The solid is dried in a draft oven at 50°C to constant weight. Mometasone furoate monohydrate, 316.5g, weight yield 90%, is obtained having an infrared spectrum and X-ray diffraction graph substantially the same as that in Figures 1 and 2.

### EXAMPLE 3

An aqueous nasal suspension of mometasone  
10 furoate monohydrate is prepared from the following:

<u>Ingredients</u>	<u>Concentration</u>	<u>Representative Batch</u>
	<u>mg/g</u>	<u>g/12kg</u>
Mometasone furoate monohydrate	0.5	6.0
Avicel RC 591*	20.0	240.0
Glycerin	21.0	252.0
Citric Acid	2.0	24.0
Sodium citrate	2.8	33.6
Polysorbate 80**	0.1	1.2
Benzalkonium chloride	0.2	2.4
Phenylethyl alcohol	2.5	30.0
Purified water q.s. ad	1.0 g	12.0 kg

\*Avicel RC-591-is a trademark of FMC for a mixture of microcrystalline cellulose and sodium carboxymethyl cellulose.

\*\*Polysorbate 80 is a tradename for a mixture of an oleate ester of sorbitol and its anhydride copolymerized with approximately 20 moles of ethylene oxide for each mole of sorbitol and sorbitol anhydride.

20 After dispersing the Avicel RC 591 in 6 kg of purified water, the glycerin is added thereto. The citric acid

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and sodium citrate is dissolved in 240 ml of water, said solution is added to the Avicel-glycerin dispersion with mixing. In a separate vessel, Polysorbate 80 is dissolved in approximately 400 ml of purified water with stirring. The 5 mometasone furoate monohydrate is dispersed in the aqueous Polysorbate 80 solution and; said slurry is then added with stirring to the Avicel-glycerin citric acid mixture. After dissolving benzalkonium chloride and phenylethyl alcohol in purified water, said solution is added to the suspension 10 mixture with stirring. The suspension is brought to 12 kg with purified water with mixing. The final pH of the suspension is  $4.5 \pm 0.5$ .

#### EXAMPLE 4

15

The following compositions were prepared without the suspending agent, Avicel RC-591 to prevent interference in X-ray diffraction studies:

<u>Ingredients</u>	<u>Concentration</u>			
	<u>mg/g</u>	<u>4A</u>	<u>4B</u>	<u>4C</u>
Mometasone Furoate	0.5	0.5	0.5	
Monohydrate Micronized				
Citric Acid Monohydrate	2.0	2.0	2.0	2.0
Sodium Citrate Dihydrate	2.8	-		2.8
Sodium Phosphate Dibasic	-	4.0		-
Polysorbate 80	0.1	0.1	0.1	
Benzalkonium Chloride	0.2	0.2	0.2	0.2
Phenylethyl Alcohol	2.5	-	-	
Potassium Sorbate	-	3.4		-
Propylene Glycol	-	-		100.0
Glycerin	21.0	21.0	21.0	
Water Purified USP q.s. ad	1.0 g	1.0 g	1.0 g	

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These compositions were prepared according to the procedure described in Example 3.

The three compositions 4A, 4B and 4C were 5 rotated for five (5) days at 35°C and a additional four (4) weeks at room temperature to assess crystal form stability. The crystals were isolated from the suspension and X-ray diffraction patterns determined. The results indicated that 10 the crystals collected from each of the three compositions are in the form of mometasone furoate monohydrate.

#### EXAMPLE 5

The following compositions were prepared and 15 tested to determine thermal stability of said compositions.

<u>Ingredients</u>	<u>Concentration</u>			
	<u>mg/g</u>	<u>5A</u>	<u>5B</u>	<u>5C</u>
Mometasone Furoate	0.5	0.5	0.5	
Monohydrate Micronized				
Citric Acid Monohydrate	2.0	2.0	2.0	2.0
Sodium Citrate Dihydrate	2.8	-		2.8
Sodium Phosphate Dibasic	-	4.0		-
Polysorbate 80	0.1	0.1	0.1	0.1
Benzalkonium Chloride	0.2	0.2	0.2	0.2
Phenylethyl Alcohol	-	2.5		-
Potassium Sorbate	-	-		3.4
Propylene Glycol	100.0	-	-	
Glycerin	21.0	21.0	21.0	
Avicel RC-591	20.0	20.0	20.0	
Water Purified USP q.s. ad	1.0 g	1.0 g	1.0 g	

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The compositions were prepared according to the procedure described in Example 3.

The compositions were thermally cycled between

5 4°C (24 hours) and 30°C (24 hours) for a period of one month. Microscopic analyses revealed no detectable mometasone furoate monohydrate crystal growth under these conditions.

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WE CLAIM:

1.  $9\alpha,21$ -dichloro- $16\alpha$ -methyl- $1,4$ -pregnadiene- $11\beta,17\alpha$ -diol- $3,20$ -dione- $17$ -( $2'$ -furoate) monohydrate.  
5
2. A process for preparing  $9\alpha,21$ -dichloro- $16\alpha$ -methyl- $1,4$ -pregnadiene- $11\beta,17\alpha$ -diol- $3,20$ -dione- $17$ -( $2'$ -furoate) monohydrate which comprises:  
10 (a) forming a saturated water-miscible organic solvent solution of  $9\alpha,21$ -dichloro- $16\alpha$ -methyl- $1,4$ -pregnadiene- $11\beta,17\alpha$ -diol- $3,20$ -dione- $17$ -( $2'$ -furoate);  
15 (b) adding sufficient water to form a solvent mixture ratio of 1:1 (water:organic solvent) and continuing stirring to complete crystallization.
3. The process of claim 2 wherein the organic solvent is selected from the group consisting of ethanol, isopropanol, acetone, dioxane and ethyl acetate.  
20
4. A pharmaceutical composition comprising an antiinflammatory amount of mometasone furoate monohydrate in a pharmaceutically acceptable carrier.  
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5. The composition of claim 4, having the following ingredients:

Ingredients	mg/g
Mometasone furoate monohydrate	0.1-10.0
Microcrystalline cellulose and sodium carboxymethyl cellulose	20.0
Glycerin	21.0
Citric acid	2.0
Sodium citrate	2.8
Polysorbate 80	0.1
Benzalkonium chloride	0.2
Phenylethyl alcohol	2.5
Purified water q.s. ad	1.0 g

6. The composition of claim 5 comprising 0.5mg of mometasone furoate monohydrate.

FIG. 1

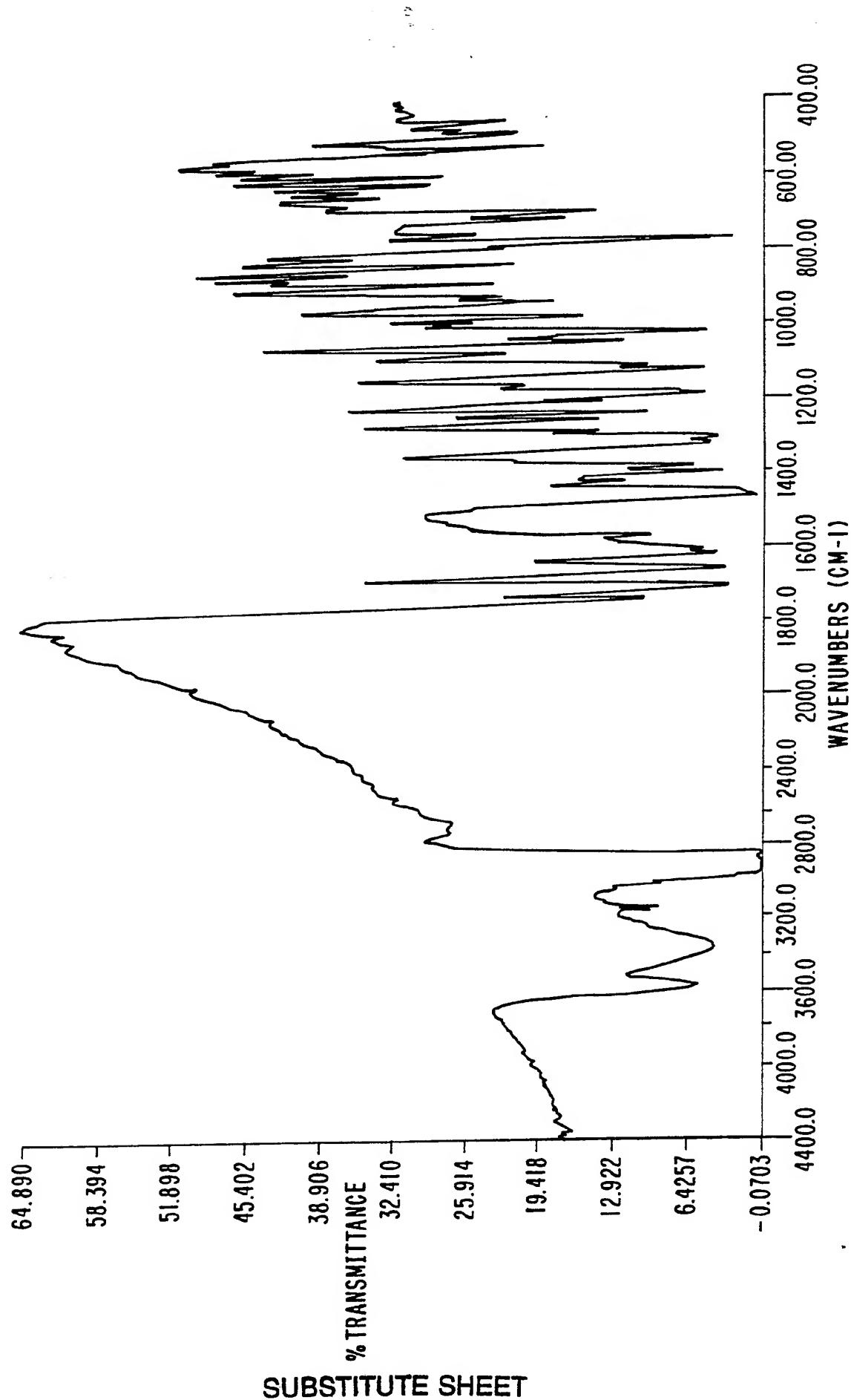
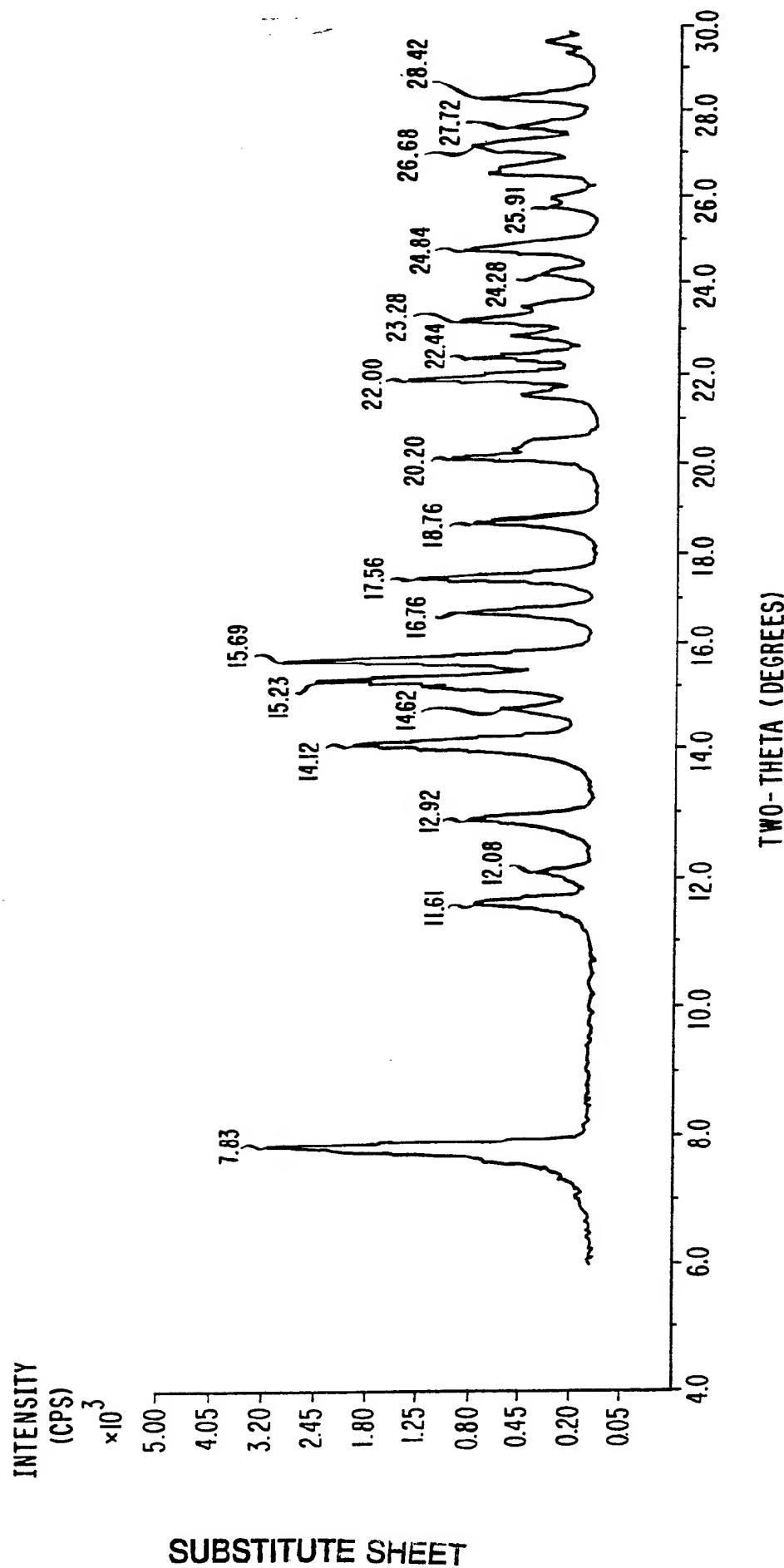


FIG. 2



# INTERNATIONAL SEARCH REPORT

International Application No.

PCT/US 91/06249

## I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)<sup>6</sup>

According to International Patent Classification (IPC) or to both National Classification and IPC  
 Int.C1.5 C 07 J 17/00 A 61 K 31/58

## II. FIELDS SEARCHED

Minimum Documentation Searched<sup>7</sup>

Classification System	Classification Symbols	
Int.C1.5	C 07 J 17/00	A 61 K 31/00

Documentation Searched other than Minimum Documentation  
to the Extent that such Documents are Included in the Fields Searched<sup>8</sup>

## III. DOCUMENTS CONSIDERED TO BE RELEVANT<sup>9</sup>

Category <sup>10</sup>	Citation of Document, <sup>11</sup> with indication, where appropriate, of the relevant passages <sup>12</sup>	Relevant to Claim No. <sup>13</sup>
A	US,A,4775529 (J.A. SEQUEIRA) 4 October 1988, see the whole document -----	1-5
A	EP,A,0262681 (SCHERING CORP.) 6 April 1988, see the whole document -----	1-5

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## IV. CERTIFICATION

Date of the Actual Completion of the International Search

19-12-1991

Date of Mailing of this International Search Report

12.02.92

International Searching Authority

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**ANNEX TO THE INTERNATIONAL SEARCH REPORT  
ON INTERNATIONAL PATENT APPLICATION NO.**

US 9106249  
SA 51039

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 23/01/92. The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

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